DOCUMENT RESUME

ED 036 365 RC 004 071

AUTHOR	GIBBS, DORIS; BROOCH, ANN
TITLE	INDIVIDUALIZING MATHEMATICS IN THE SMALL SCHOOL.
INSTITUTION	COLORADO STATE DEPT. OF EDUCATION, DENVER.
SPONS AGENCY	FORD FOUNDATION, NEW YORK, N.Y.
PUB DATE	64
NOTE	30P.
EDRS PRICE	EDRS PRICE MF-$0.25 HC-$1.60
DESCRIPTORS	*GRADE 7, *GRADE 9, *INDIVIDUALIZED INSTRUCTION, *MATHEMATICS INSTRUCTION, PROGRAMED MATERIALS, *SMALL SCHOOLS, TABLES (DATA), TESTING
IDENTIFIERS	WESTERN STATES SMALL SCHOOLS PROJECT

ABSTRACT

TWO COLORADO TEACHERS' ATTEMPTS TO INDIVIDUALIZE MATHEMATICS INSTRUCTION IN GRADES 7 AND 9 IN SMALL SCHOOLS ARE REVIEWED. THE SEVENTH-GRADE TEACHER UTILIZED MULTI-LEVEL TEXTBOOKS IN INDIVIDUALIZING INSTRUCTION. THE RESULTS OF THE PROGRAM WERE EVALUATED BY THE CALIFORNIA ARITHMETIC TEST. GRADE PLACEMENT FOR REASONING AND MATHEMATICS FUNDAMENTALS WAS RECORDED IN SEPTEMBER AND IN MAY; PERCENTILE STANDINGS OF THE STUDENTS WERE INDICATED, AND SCORES WERE RECORDED FOR THE SEQUENTIAL TESTS OF EDUCATIONAL PROGRESS AND THE SCHOOL AND COLLEGE APTITUDE TESTS. A FINAL TEST USED IN EVALUATION WAS THE COOPERATIVE MATHEMATIC TESTS (EDUCATIONAL TESTING SERVICE). THE NINTH-GRADE MATHEMATICS TEACHER, WHO UTILIZED PROGRAMED MATERIALS IN INDIVIDUALIZING INSTRUCTION, CONCLUDED THAT THE PROGRAMED-MATERIALS METHOD OF INSTRUCTION REACHES MORE STUDENTS THAN THE TRADITIONAL METHOD. (SW)

COLORADO WESTERN STATES SMALL SCHOOLS PROJECT

DOCUMENTATION

[Individualizing Mathematics in the Small School]

[1964]

A Plan for Individualizing Instruction in Seventh Grade Mathematics Through the Use of Multi-Level Textbooks

by Doris Gibbs

Individualized Instruction. Freshman Mathematics

by Ann Brgoch

COLO. STATE DEPT. OF EDUCATION · DENVER
BYRON W. HANSFORD
COMMISSIONER

THE WESTERN STATES SMALL SCHOOLS PROJECT

The Western States Small Schools Project, partly financed by a grant from the Ford Foundation, is designed to help the state education agencies in Colorado, Arizona, Nevada, New Mexico, and Utah in their efforts to improve instruction in the necessarily existent small schools. The Project began January, 1961 and will end August, 1965. Policy Board of the Project is composed of the chief state school officers of the cooperating states. Ralph G. Bohrson, Coordinator of the WSSSP, is headquartered in Denver, at the Colorado State Department of Education.

The Colorado portion of the Project, involving more than two hundred teachers and administrators in approximately thirty schools has been working in the following areas:

-- Ungraded or Continuous Progress Programs

-- Use of Self-Instructional Materials

-- Teacher Education and In-Service Programs

-- Institutes for Rural School Board Members

For additional information concerning the Colorado WSSSP, contact:

Edwin R Hildebrand
~~Paul M. Nachtigal~~, Director
Colorado Western States Small Schools Project
State Department of Education
Denver, Colorado 80203

Mrs. Doris Gibbs
Ridgway High School
Ridgway, Colorado
1963-64

A PLAN FOR INDIVIDUALIZING INSTRUCTION IN SEVENTH GRADE MATHEMATICS THROUGH THE USE OF MULTI-LEVEL TEXTBOOKS

I. OVERVIEW

Ridgway School is a small school of approximately 60 students in grades 7 through 12. It is located in a farming and ranching district just 10 miles from Ouray, Colorado, which is a mining community. The town of Ridgway has a population of approximately 254 people. Half of the students are transported.

On an average there are about 10 pupils to a class. This is an ideal situation for the teacher to work individually with each one. This is the reason I wanted to try different work for each student, hoping that once the pressure of the group was off, much more and better work would be done.

I felt that the above average student in mathematics was not taxed in mathematical thinking. Realizing that most math students need work in addition, subtraction, multiplication, division, etc., I felt that others were losing precious time. This time could better be spent in the "why" of the process as the fundamentals were reviewed.

This project is not one that can be completed at the end of one year. To be sure, it is possible to gauge to some extent the result so far as needs, interest, enthusiasm, determination, and progress are concerned. However, my plan is to see whether better mathematics and science people are developed during the entire high school program.

I feel that the "Modern Math" will help the above average student have a feeling for abstractness so that he will be ready and able to go on into advanced math studies. His college math courses should, therefore, be easier for him and more quickly completed. I feel that this modern course will have a definite carry-over in the field of science. They will be ready to study science instead of having to also grasp scientific terms.

As I went back to school to study this "New Math", I was amazed at the many new things junior high and high school students were expected to squeeze into their math learning. As we discussed problems in our seminar, it seemed to be the consensus of opinion that the average (perhaps) and the above average students are the only ones capable and interested in the "why" of our numbers and number system. Certainly abstractness cannot be grasped by any but the better students. After thinking about these things, I decided to see whether the new math would be more stimulating than a regular course. I also thought it could be a big help in higher math courses as well as the science field.

II. PROCEDURE

As is true in every school, most students will only do what is required of them. Even outstanding students have to be highly motivated to want to do more than the average person. Of course in the fall, review of fundamental arithmetic principles is necessary. I did not realize how necessary it is for even the better students until I gave the California Arithmetic Test in the fall (see Table 2). However, there are different ways of re-teaching fundamentals. There is the old drill method which seems to be the best for your slower students. There is the method of solving written problems whose solving makes one very conscious of the fundamental principles. There is the method of learning new principles while you are re-establishing old fundamental principles.

I felt that the above average students would have no trouble going on with new things while re-learning old ones. They didn't. As you can see by the percentile standing in fundamentals in May (see Table 3) both top students ended up with fundamentals mastered. They were not afraid to work on their own and with a little help now and then could go twice as fast as the third top student.

So far as outstanding I.Q.'s (see Table 1), there are none. The average for the class is approximately 105, which is a good average class.

This class as a whole was used to having all kinds of teacher help. It was impossible to put the group all on their own immediately in the fall. I found it necessary to proceed as they were used to--daily assignment and daily recitation. However, I did have the below average students together in one group alone and the average and above average students in another group. This was to be a beginning for having one group independent of me while I was helping the other group.

At first this was very discouraging. The slower group could hardly get one problem done by next day unless I was there helping them think. I wondered how I could ever get them even partially independent. Perhaps my trouble came from the fact that this was the first time they just had to get it. Always before in their classes the brighter ones were there to help out if they were needed. The teacher could eventually get the right answer from the brighter ones or the slow student could get help with his homework (even if it did become just a copying act). Now here, they were having to get it by themselves or by helping each other.

For a while it appeared that I was wasting everybody's time. What a wonderful feeling it was when the first of the slow group "caught on". From then on, he could work alone and seemingly had a much better idea of what math was all about.

I did not use programed materials at all, but my process was very similar. The answer keys were available to any student at any time. If a pupil felt that perhaps he did not know what he was doing, he would check the answer after working only one problem. If he knew his process was right, he would usually wait until the end of the set of problems before checking his paper. Any problem missed was to be worked until the right answer was obtained. If the right answer wasn't forthcoming, he was not sure whether there was a mistake in the key or whether his work was wrong. Here is where the teacher came in. Together we would go through the thinking process. If his way of working the problem seemed to be right, then we would check fundamental arithmetic processes. If his mistake was

in addition, subtraction, multiplication, or division, he was very much chagrined to think that he went over and over the problem and could not find such a simple mistake.

At the end of certain phases of work, there was a test to be taken. I did not rush individuals into taking the test. I would emphasize that they had to know each principle in the work they had covered before trying the test. When they were ready for the test, they told me. If a certain score, usually 80 for the average student, was not received on the test, I felt that the material needed to be covered. There were principles that the student had not grasped or he would have received a better grade on the test.

This is where I feel my program needs to be improved. I need to spend more time getting together certain phases of remedial work. I would pick special problems from special pages that seemed to be the material the students needed to go over again. But here is where my students began to be bored. They were used to forging ahead, regardless. So long as they were covering new material all seemed well, but a "retake" was the end of their enthusiasm. I plan another year to use workbook sections, special remedial booklets which the California Testing Bureau makes for remedial work to help develop reasoning power and fundamental powers, other texts from which I can gather my own programed material.

My poorer students were not expected to get a score of 80 on their tests although some of them did. I was very happy to find that they could pass the tests. When working with groups in the classroom, you very seldom go slow enough for the slow learner to get enough to pass any text. The only trouble is that when you leave them on their own, they don't get through very much material during the course of the year. But in my own mind, I am sure that what they do get will stay with them better for having learned it more thoroughly while they were at it.

Just because the students use the answer keys to correct their own work until their solution is perfect does not mean that the teacher has been able to do away entirely with daily paper grading. I found that some of the students would try harder to make the teacher think they had corrected all problems than they would try to actually work out the process until the solution was right. Some would put a solution on th[illegible] paper and at the bottom would be the right answer but the solution, if followed through, would not yield that answer.

By the end of the year most individuals were trying hard to be sure every problem was corrected, but some never quite realized that "honesty is the best policy".

I also had trouble, as I had anticipated, with the amount of work done. My two outstanding students gave no problem here. They were interested in what they were doing and were interested in learning all they could. However, they are slow workers so I know that many other students could have been much farther along than they were when school was out.

Somehow, I need to find a way to keep the average students going. I required no homework although we have only 50-minute periods in most of our classes. When I say required no homework, I mean to say that I talked favorably for it and certainly tried to encourage it but did not make it a requisite of the course. Again, I had no trouble encouraging the better students but the rest of the class were inclined to be lazy. The top two individuals were enthused about the challenge material given to them. I believe it was the first time in their school life that they had found that math made them think and dig. But the rest worked hard during class but that was usually the end of their math thoughts until the next day. The problem of "how to motivate" is still plaguing me.

Perhaps you have been wondering how I decided where to place each individual. In the first place, as I told you previously, I divided my class into two groups--

the below average group and the average and above average group. This was done by checking I.Q.'s (see Table 1) and having consultation with their former math instructor. In the average group, particularly, you usually find lazy individuals. Here was my problem. How much work could I get them to do? Finally I decided that I would expect the best from them and if they did not give me their best, I might have to do other things with them. I had to change one individual from the upper group to the lower group.

I chose two different texts which in turn have material in them for various levels of achievement--Modern Math by Rosskopf, Morton, Hooten, Sitomer, Silver Burdett Co. and Math at Work by Fehr & Schult, D. C. Heath & Co. My average and above average students were given the Modern Math book. The other book also contains modern math topics but is not so hard so far as the approach or the problems given.

III. EVALUATION

Some of the parents of the students using the modern math book wondered when the "frills" were to be stopped and basic fundamentals begun. I tried to get the pupils to see that fundamentals were also being reviewed while these extras were being explored. I tried to show them that they were learning the "why" as well as the "how". Most responded. By checking Table 2, I feel that sufficient gain was made in fundamentals.

I was a little discouraged with the gain made in reasoning ability. Too many individuals were still asking for help on written problems. I hope in another year or two that more independence will be shown on the part of these average students particularly.

Another thing I noted was that my slower students, as well as the rest of the class, handled fractions better at the end of the review period than any other group of seventh graders I have had.

Grading is a serious problem for me. Sometimes very little progress is made within a six-weeks period. Perhaps the student is slow or lazy and does no homework. His first test on the material is not good, so he is given remedial work. Maybe he finishes one unit during the grading period. When you have to grade with A, B, C, D, F, it is very hard to determine the grade that will be fair to him.

Next year, I would like to somehow change the grading system for this class. I would like to be able to figure out just how far each student should be expected to go in the textbook. I am afraid that by setting a definite page in the book I will be defeating my purpose. I was trying to discourage my setting a goal and encourage the students' setting a goal. If I set a goal, I feel that I will be right back where I was in group teaching--taking the pupils so far whether understanding was there or not.

The school gave STEP and SCAT tests at the close of the first semester. Table 4 shows how my seventh grade pupils did on the math section and natural ability section. A tabulation of the students' I.Q.'s are shown in Table 1 so that they may be checked against actual accomplishments.

Other than my own tests I gave only one standardized test, California Arithmetic Tests for Junior High Level. This was given in September and a different form of the same test was given in May. Although I did not feel these tests to be adequate, they did give me one picture of the evaluation. I do not know what the improvements would have been in group teaching but can only theorize.

Notice that the poorest student (Student F) made an improvement of nearly one whole grade placement. The poorest improvement was made by Student D who only improved by .4 of a grade. However, he is still slightly higher than average. The better individuals improved 2.4 and 3.4 grade placements.

Following is a resumé of the results of the tests given. The diagnostic profile chart for each student contains shaded areas to the right and left sides

of the chart. Scores in the shaded area to the right suggest that the student can function above the range of grades for which the test was specifically designed. Scores in the shaded area to the left suggest that the student is functioning below this range. Thus, if the majority of the student's scores fall in the shaded area to the right of the profile, another test using the advanced level should be given to yield a more accurate evaluation of his actual achievement. Also a more accurate evaluation could be shown by giving the elementary level test to those students whose scores fall mostly in the shaded portion to the left of the chart.[1]

For the student who is of average ability or less, a vertical line was drawn on their profile chart one grade placement to the left of his actual grade placement. If scores on any tests hit on or to the left of this line, there is a definite weakness that needs to be worked on. For some of the students who have demonstrated average ability and for those with above average ability, the vertical line was drawn one school grade to the left of his mental age. Even when all the test scores are to the right of the line, one or more scores may be low in relation to the test score and the scores of the other sections of the test.

In figuring percentile ranks, I was very careful to see that the correct grade placements were used. Some percentages jumped decidedly.

Student B

September: Arithmetic meaning and symbols, rules, and equations used in reasoning fell to the left of the line that was drawn one grade placement to the left of his mental age grade placement. Division as a fundamental process fell in the shaded left.

May: No scores were on or to the left of the line drawn according to his grade placement. The lowest score was found in symbols, rules, and equations used in reasoning.

1. Tiegs, Ernest W. & Clark, Willis W. in "California Achievement Tests Manual", California Test Bureau, Del Monte Research Park, Monterey, California.

There was a decided jump in both arithmetic reasoning and arithmetic fundamentals during the year. The percentile jump was from 20 percent to 82 percent. His arithmetic grade placement in the fall was 6.2 and in the spring 8.7. The STEP math score showed that he seems to be working to his ability. Perhaps this is an indication that he leaned on others in the class before. Now what he got, he got for himself and retained it.

Student G

September: Arithmetic meanings in reasoning and subtraction fundamentals fell in shaded right. Addition, multiplication, and division as fundamentals all fell to the left of the line drawn one grade placement to the left of the mental age placement.

May: No score was on or to the left of the line drawn according to mental age placement. In fact all scores but one were in the shaded area to the right. In order to tell just where this individual stands, an advanced level test should be given.

The lowest score was in division but it just missed the shaded right area. There was a large improvement in arithmetic fundamentals. The overall percentile jump was from 96 to 99+. This person's arithmetic grade placement in the fall was 8.9 and in the spring 11.3.

Student H

September: Arithmetic meanings in reasoning fell in the shaded right area. All other scores on the test fell to the left of the line drawn one grade placement to the left of the mental age placement with multiplication fundamentals being particularly low.

May: The line drawn one grade placement to the left of the mental age placement is in the shaded area to the right of the chart. This person should be given an advanced level test to find out just what is known. All fundamentals are

to the right of the line which is already in the right shaded area. However, I find this person to be weak in all phases of arithmetic reasoning. They all are found to the left of the line at approximately grade 9 level.

There was a tremendous improvement in arithmetic fundamentals and quite an improvement in arithmetic reasoning. To me this indicates that fundamentals are learned better by not stressing them as such. The percentage jump was from 58 in the fall to 99+ in the spring. The grade placement changed from 7.3 to 10.7. The STEP test also found this student to be in the 99th percentile in math.

Student D

September: All scores fell to the right of the line drawn one grade placement to the left of the mental age placement. There is one (arithmetic meanings in reasoning) that fell in the shaded area to the right. Although multiplication was to the right, it shows a deficiency (below actual grade level).

May: Again all scores are to the right of the line drawn one grade placement to the left of the mental age placement. Arithmetic meanings in reasoning is again in the shaded right area; so is addition as a fundamental process. Subtraction, multiplication, and division scores are a little lower than actual grade level and show that remedial work is needed. There were slight improvements but one big one in addition. The percentile score shows a loss from 82 to 78. The grade placement changed from 8.1 to 8.5. The STEP test found a percentile score in math of 79.

Student I

September: All reasoning scores were slightly to the right of the line drawn one grade placement to the left of mental age placement. This person is a little weak in symbols, rules, and equations. All scores in the fundamentals (addition, subtraction, multiplication, and division) were to the left of the line with division being very poor--in the shaded left area.

May: Only one score, multiplication, remained to the left of the line drawn according to mental age placement. Comparison of the two tests shows that most improvement came in use of the fundamentals. Multiplication did not improve but the others showed a decided jump. Percentile scores improved from 50 to 68 with grade placement increasing from 7.0 to 8.2. The STEP test showed a percentage of 84 in math.

Student A

September: All scores but one (subtraction fundamentals) lie to the left (and in the shaded area) of the line drawn one grade placement to the left of actual grade placement. This means that the test was too hard.

May: Reasoning problems and meanings in reasoning still are on or to the left of the line. Written problems score lies in the shaded area to the left. All fundamentals improved and lie to the right of the line although all are still slightly below actual grade level.

There was a decided improvement in the work of this individual. She shows that much help is needed in order for her to be able to understand and work written problems. Percentage scores show improvement from 7 to 36. Grade placement rose from 5.2 to 7.2.

Student F

September: Every score on the test will be found to the left of the line drawn one grade placement to the left of actual grade placement. Each score is also in the shaded left portion. An easier test should be given to determine just where this individual stands. This person has no idea as to arithmetic meanings.

May: Arithmetic fundamentals, subtraction and multiplication, jumped to the right of the line. All other test scores are to the left of the line and in the shaded portion. Very little improvement was made in the percentile rank--from 5

to 8 percent. Grade placement, however, did improve from 4.9 to 5.8. According to the STEP test, 21 was the percentile score obtained in math.

Student C

September: Weakness is shown in arithmetic meanings as this score is found on the line drawn one grade placement to the left of mental age placement. Symbols, rules and equations score is to the left of the line.

May: All scores remained out of the shaded areas. Meanings and written problems scores are to the left of the line drawn one grade placement to the left of mental age placement. Division score is on the line with other fundamentals to the right. There was a big improvement in most of the fundamentals. The percentile scores on the total arithmetic test increased from 36 in the fall to 60 in the spring. Grade placement increased from 6.6 to 8.0.

Student E

September: Arithmetic meanings, subtraction, and division are found to the right of the line drawn one grade placement to the left of actual grade placement. All other scores are to the left of the line. Written problems, addition, and multiplication are in the shaded area to the left.

May: All scores with the exception of addition fundamentals are found to the right of the line drawn one grade placement to the left of actual grade placement. However, all of the fundamentals remain lower than actual grade placement. In arithmetic reasoning all scores are approximately on actual grade placement. Addition is in the shaded left portion. Much work needs to be done here.

Percentile scores started at 28 percent last fall and ended with 44 percent in the spring. Grade placement rose from 6.3 to 7.5.

On the following page, Table 1 shows the class I.Q.'s, grade placements, percentiles and results of the STEP and SCAT tests.

TABLE 1

(Average Indicated I.Q. of the Henmon Nelson Test of Mental Ability and The California Mental Maturity Test)

Student	Average I.Q.
A	90
B	105
C	107
D	106
E	96
F	82
G	125
H	128
I	107

TABLE 2

Class Summary
California Arithmetic Test Grade Placement

(SEPTEMBER, 1962)

Reasoning	Fundamentals	Total
9.7	8.0	8.9 (Student G)
8.6	7.5	8.1 (" D)
7.7	6.9	7.3 (" H)
7.6	6.9	7.0 (" I)
6.8	6.3	6.6 (" C)
6.6	6.3	6.3 (" E)
5.4	6.0	6.2 (" B)
4.5	5.9	5.2 (" A)
4.5	5.3	4.9 (" F)

(MAY, 1963)

10.9	12.3	11.3 (" G)
9.0	11.8	10.7(" H)
9.0	8.8	8.7 (" B)
8.5	8.0	8.5 (" D)
8.5	8.0	8.2 (" I)
8.0	7.9	8.0 (" C)
7.9	7.4	7.5 (" E)
7.0	6.9	7.2 (" A)
4.6	6.9	5.8 (" F)

TABLE 3
CLASS SUMMARY
CALIFORNIA ARITHMETIC TEST
PERCENTILE STANDING

(SEPTEMBER, 1962)

Reasoning	Fundamentals	Total
98	80	96 (Student G)
90	68	82 (" D)
68	48	58 (" H)
60	40	50 (" I)
40	30	36 (" C)
36	25	28 (" E)
16	48	20 (" B)
7	25	7 (" A)
7	10	5 (" F)

(MAY, 1963)

99+	99+	99+ (" G)
88	99+	99+ (" H)
75	80	82 (" B)
88	60	78 (" D)
75	58	68 (" I)
58	60	60 (" C)
60	32	44 (" E)
35	44	36 (" A)
4	34	8 (" F)

TABLE 4
STEP and SCAT
FEBRUARY, 1963

No. of Student	Math	Natural Ability
A	8	35
B	91	76
C	69	50
D	79	66
E	62	54
F	21	8
G	98	99
H	99	97
I	84	73

IV. SUPPLEMENTARY PROCEDURE AND EVALUATION

Since this study is to be a continuing thing, I would like to continue my first year's results with a few observations and changes made during the second year.

I feel that this individualization worked very well with the better students. You can see by the tables that irrespective of the kind of test given that the two outstanding students reached close to the 99th percentile.

I did try changing my grading system in 1963 64. Each student chose his own goal. Although he did not always reach it, he had a goal for which to try, making him respond better. I did not penalize him for material not covered, unless it was apparent to me he was not trying. I requested twenty minutes work each day outside of math class for homework. Each day each student filled out a slip telling me how much homework was done and what work was accomplished. More material was covered and I believe it was mastered just about as well.

So long as students were keeping up, they could work at the "lab" table once a week. On this table was a variety of projects from which the individual could choose. Below is a sample of the copy given each student. I had two outstanding notebooks at the end of the year.

POSSIBLE PROJECTS

Project Day is Voluntary

1. Scale drawings. You may use an encyclopedia or other books to know the proportioned size of drawings such as aircraft, house plans, one piece of furniture, a building, a yard plan, etc. You are to choose a different scale and make an attractive drawing of your own. At the bottom of your picture, please give the name of the author, the name of the book, the name of the publishing company, year of publication of the book, and the page number so that I may check to be sure you used a different scale from that used in the book. (Don't forget that in scale drawings the scale you use must be by your picture.)

2. Every month we need a different bulletin board display. Perhaps you would like to collect jokes about math or those related to science. Perhaps you can find attractive pictures to use, etc. If you choose to do this, please plan to make one complete bulletin board display, attractively arranged. (If construction paper is needed, we have some you may use.)

3. Choose some model you have been dreaming about building. Make a small working model of it out of toothpicks, light wood, cardboard, or the like.

4. There are many other textbooks that have chapters or sections in them that are new to you. You may choose to study these parts and write in your notebook an outline of the topic you choose.

5. The journal "Science and Math Weekly" contains many interesting articles on science and math. Read any one or all of the articles, summarizing them in your notebook.

6. There is a list of booklets available for your project grade. You may choose to work in any of the books on your list.

7. If you have ideas for a project that is different from the above, please see me to get an o.k. to go ahead with it.

For reasons of comparison, I gave different forms of the California Arithmetic Test for Junior High Level again in the fall of 1963 and the spring of 1964. The results are shown in Tables 5 and 8. Although the gains do not seem to be as large as during the previous year, we must remember that for some individuals 8th grade math is not easy to comprehend. I noticed that grade placements did not drop very much from the spring of 1963 to the fall of 1963. This is an indication to me that the work covered the previous year must have been learned and not just gone over.

As in the first year, many scores from the California Test fell in the shaded area to the right of the chart. So in April, 1964, I gave the math test of the Cooperative Test Division, Educational Testing Service. The test was divided into four parts. I have given the class percentile ratings on each part in Table 7. The two outstanding students are still pretty well at the top.

TABLE 5
CALIFORNIA ARITHMETIC TEST
GRADE PLACEMENT, SEPTEMBER, 1963

Reasoning	Fundamentals	Total	
11.2	11.1	11.2	(Student G)
10.5	9.3	9.9	(" H)
8.9	9.3	9.1	(" D)
8.3	8.7	8.5	(" I)
8.3	8.4	8.3	(" B)
7.6	7.5	7.5	(" C)
7.6	7.5	7.5	(" E)
6.2	7.3	6.8	(" A)
4.5	6.4	5.5	(" F)

PERCENTILE STANDING, SEPTEMBER, 1963

99+	95	99+	(Student G)
96	75	92	(" H)
76	74	78	(" D)
58	64	62	(" I)
58	58	58	(" B)
38	35	32	(" C)
38	35	32	(" E)
12	30	10	(" A)
1-	14	3	(" F)

- -

TABLE 6
CALIFORNIA ARITHMETIC TEST
GRADE PLACEMENT, MAY, 1964

Reasoning	Fundamentals	Total	
12.6	13.5	13.1	(Student G)
11.8	12.0	11.9	(" H)
10.3	10.4	10.4	(" D)
9.3	10.7	10.0	(" I)
9.7	9.5	9.6	(" B)
9.1	9.5	9.3	(" A)
8.5	9.9	9.2	(" C)
9.9	8.1	9.0	(" E)
6.4	7.6	7.0	(" F)

PERCENTILE STANDING, MAY, 1964

99+	99+	99+	(" G)
98	97	99	(" H)
88	84	87	(" D)
68	86	82	(" I)
78	68	72	(" B)
61	60	66	(" A)
48	76	65	(" C)
82	37	60	(" E)
8	27	15	(" F)

TABLE 7

COOPERATIVE MATHEMATIC TESTS
GRADES 7, 8, and 9
EDUCATIONAL TESTING SERVICE

PERCENTILE RANK

No. of Student	Skills	Facts, Terms, Concepts	Applications	Appreciation
G	99+	99	93	99+
H	99+	96	78	99+
D	74½	70	63	55
I	74½	63	59	23
B	25	63	80	79
C	35	63	24	55
E	25	31	14½	44
A	21	34½	19	36
F	21	7	0	0

V. CONCLUSIONS

This project has helped me greatly as a teacher. I feel that I am much more wide awake, trying always to find something that will help one student at a time build a bridge across his chasm. Minimum paper grading has enabled me to use my time preparing in advance the materials each student will need.

In closing let me say, "It is all for the good of the student that realistic but challenging standards of achievement in mathematics be established at the earliest possible moment. Success in mathematical subjects does not come without challenge and the earlier the challenge occurs, the better will be those who are able to meet the challenge."[1]

1. From the College Point of View in "Colorado Mathematics Teacher", 1962

INDIVIDUALIZED INSTRUCTION
FRESHMAN MATHEMATICS
Ann Brgoch
LaVeta High School

[1964]

BACKGROUND

When I began my teaching career in the LaVeta Schools ten years ago, I was amazed at the lack of mathematical understanding in the students. LaVeta, located in a beautiful little valley along the Sangre de Cristo Range, is a small community of about one thousand people. There are no industries or anything else located here that would require a mathematical vocabulary to any great extent. The principle industry is cattle raising.

I soon realized that in this very fast-changing world of ours, our students could not hope to compete with students from large schools in the mathematical field. I talked to several of my former mathematics students who had gone to college to see if I had given them a mathematical background that enabled them to progress along with their fellow students from larger schools. Most of these former students were above average in mathematics but felt that they had been handicapped by the limitations placed on them in high school by the slower students.

While attending the Western States Small Schools Project Workshop at Greeley, I began to realize that individualization, aided by the use of programed materials, could help to alleviate this situation to some extent.

Providing for children of varying abilities in mathematics was a problem that I had to cope with in order to get maximum results from my freshman students. Due to a limited faculty and a small student body, problems arose in scheduling classes. This made it necessary to require Algebra I of all freshmen. Many of the students found Algebra very difficult and frustrating while others could grasp it easily and thought it was fun. My teaching had to be geared to the average. I discovered that the good students became bored while the slower ones were finding it difficult to keep up.

SUMMARY OF RELATED RESEARCH

More and more educators are evaluating curriculum programs to ascertain what can be done to meet the academic needs of pupils whose differences vary according to abilities and interests. One of the greatest problems has been in the field of mathematics because it is one of the fastest growing and most rapidly changing of the sciences. Many teachers and parents are aware that the standard eighth grade mathematics offers little challenge to the academically talented youngster. Some schools offer enrichment programs which most of the students feel is just "extra" work and frequently called "extra work". These students become bored and develop poor study habits.

In Memphis, Tennessee, the students with very low grades were advised not to take Algebra. However, if a student insisted on enrolling in Algebra, even after being advised otherwise, he was permitted to do so. In the study, efforts were made to determine the relationship between success in Algebra and four variable factors: intelligence, achievement in mathematics test scores, eighth grade composite grades, and eighth grade mathematics grades.

For the purpose of this study, one hundred and fifty ninth grade algebra students were chosen from three different schools (fifty from each school). These students were arbitrarily selected from different sections in each school so as to include students who took Algebra at different periods during the day. Due to location and character of the enrollment in the three schools involved, this sample would seem to be a good cross section of ninth grade enrollment in algebra.

No attention was paid to the various teaching techniques used nor to the various social and psychological factors that might have influenced student progress. Half of the students selected were girls and half were boys.

Four independent variable factors were selected as criteria that might be used for selecting students for ninth grade Algebra and for predicting within crucial limits their mastery of the subject. They were (1) I.Q., (2) Achievement Tests, (3) Eighth Grade Composite Grades, and (4) Eighth Grade Mathematics Grades. The I.Q.'s ranged from 75 to 128. Final grades in eighth grade arithmetic ranged from 1 to 4 assuming that A=4, B=3, C=2, D=1, and F=0.

Conclusions were that eighth grade mathematics grades were found to be a better basis for prognosis that I.Q., Achievement Test Scores, or eighth grade composite averages. Scores obtained from the averages made on the arithmetic sections of the Stanford Achievement Tests correlated relatively high with achievement in Algebra. From this study, a combination of eighth grade mathematics grades and achievement test scores on the arithmetic section would appear to be a reliable predictor of achievement in Algebra.

OBJECTIVES

Individualization became one of the most fundamental concepts of my entire project. My main objective was to free the gifted students from the limitations placed upon them in a traditional classroom. By doing this, the gifted students could take five or six courses of mathematics in four years. The average college bound students could take four courses, and the others could gain enough practical mathematics to handle most ordinary situations which arise.

I felt this project could broaden the curriculum and enhance the program of our school. I attempted to develop better individual study habits in the students, placing emphasis on retention of skills rather than on covering large quantities of subject matter.

The use of programed material should allow the students to progress at their own rate and provide an opportunity for the integration of traditional and modern mathematics.

TECHNIQUES, METHODS, AND MATERIALS

I began this project by first charting the mathematics aptitude test grades, I.Q. scores, and comments of the junior high school mathematics teacher for each student entering the ninth grade. The I.Q. scores for this particular class ranged from 88 to 126. The average I.Q. was 111.

During the summer planning session, I pondered over the above and decided to divide the class into two groups. The college bound students would be placed in the S.R.A. MODERN MATHEMATICS and the non-collegiate, slower students in General Mathematics. The S.R.A. was to be programed, and the General Mathematics was to be taught in the traditional method.

The S.R.A. MODERN MATHEMATICS consists of ten books using the modern approach to high school mathematics. The principle of programed instruction is to allow a student to learn more effectively as he moves through the material in a logical sequence of small, easy-to-take steps. At each step he is asked a question on what he has learned, and he can immediately find out whether his answer is correct. A student is constantly aware of whether or not he is proceeding correctly. This helps to minimize misconceptions that can lead to poor mathematical thinking. Traditionally, when a textbook assignment is given, the student must wait some time before he finds out whether he is performing his work correctly. Many times there is a delay of many days before class time can be found to discuss homework. With programed material, the above problem is lessened since the student checks his work as he does it. Special answer booklets come with the programed textbook. I check these to see that the student has completed the work and note the percentage of errors made. These answer booklets are never graded.

Late in August, eighteen freshmen registered for freshman mathematics. The first week was spent lecturing and demonstrating the plan to be used during the year. It was difficult at first for the students

to understand what was meant by a programed course as they had never seen one. The second week of school, I divided the students into their respective groups. I had twelve students in S.R.A. MODERN MATHEMATICS and six students in General Mathematics. I taught these two subjects during the same period.

In a week, I realized that I did not have two classes but eighteen individual classes. Each student was in a different place in the programmed materials, and the progress in the traditional class was much the same.

This combined class met four days a week. The length of each period was seventy minutes. The progress slip that each student handed in at the end of the period contained the following information:

Date _____

A. Frame number at the beginning of the period _____
B. Frame number at the end of the period _____
C. Frames completed (B-A) _____
Test Grade _____
Comments _____

Signature _____

This small chore on the part of each student freed me from doing any record keeping during this mathematics period. Since tests were given to the student as he was ready for them, I saved a considerable amount of time which I could use to help the other students and the General Mathematics students.

When a student had difficulty on any problem, he wrote a comment. I checked these report slips, noting which students were having trouble. When several students were having difficulty with the same principle, I met with them on the following day and reviewed the principles again in a traditional classroom method. If only one student was having trouble, I took time to go over the material with him individually.

Upon completion of each chapter, the student took a test. Each student had to receive a grade comparable to his abilities in mathematical

achievement before he was allowed to proceed. These abilities were determined by I.Q. scores, mathematics achievement test grades in the past, and scores in quantitative thinking. In some cases the percentile was as low as 70 and in others as high as 90. These tests were graded immediately with the pupil present so if he failed the test I could review all the material individually with him before he was allowed to take another test over the same material. Some students never had to repeat a test. This indicated to me that these students were striving for accuracy and studied as they wrote the answers. One of the difficulties I first noticed was most of the answers to the questions seemed so simple and so logical that the student put the answers down without thinking. When these students took the test they did poorly on it. As they progressed, they soon realized that studying the chapter before they took a test was important.

When there seemed to be diminishing returns from programed material, I supplemented the work with assignments or reference material from the textbook MODERN ALGEBRA. This gave the student a good basis on which to proceed.

Throughout the year, I felt the need for supplementary materials. It was very difficult to find many sources of materials available in modern mathematics. As they became available, our superintendent purchased them so that by the end of the year, I had a good supply for students to refer to when problems arose.

The six students in general mathematics worked on a daily assignment plan. At the beginning of the year, I thought each student could proceed at his own pace, but I discovered that a textbook cannot be used as a programed textbook. The textbook needs the teacher to explain new methods and problems to the student. However, each student was free to progress as fast as he was capable. Since this was a slower group, there was not

so great a span in progress as in the modern mathematics class.

EVALUATING PROGRESS

In order to assist in evaluating the progress of the students in my class, I used the following facts:

1. Students were competing with themselves
2. Daily work was not graded
3. Test grades were the only recorded grades

Because of the above facts, my grading was all very subjective. I used the test grades and my judgment as to what each student had accomplished with his ability to achieve to determine his grade for the six weeks.

At the end of the year I found three students had completed the ten books, five were on Book Six, two were on Book Eight, and one was on Book Ten. The three students who had completed the ten books were given a final examination which covered the entire course. Their average score of 88 percent indicated above average learning and retention of subject matter.

At the end of the year, each of the students received one credit in freshmen mathematics although some of these students may take three years to finish the course. They will receive a credit each year, but when they transfer to a college, they will receive only one mathematics credit for this particular course.

When school begins in the fall, these students will pick up where they left off the previous year. The three students that have finished the ten books will begin geometry and Algebra II. The others will complete the freshman mathematics. As the other students complete the course, they will begin geometry.

With the limited experience I have had with programming, I believe that it reaches more students than the traditional method. In my class the top students have progressed far beyond where they would have if they

were in a regular class situation. The average are where they would have been in a regular classroom, but they have developed more self-reliance and have learned some of the modern mathematical thinking concepts. My general mathematics students will be better prepared to take Algebra I next year than they would have been at the beginning of their freshman year.

STUDENT AND TEACHER REACTION

The enthusiasm of this group was outstanding. They adjusted to the programming easier than I did and seemed to enjoy it because they could budget their own time. Friction among the students did not occur because of the differences in advancement. Instead, the better students were helping the slower students and were trying to make them understand which is far better than the usual copying which goes on in a traditional classroom.

Difficulty in the tests seemed to be the biggest complaint from the students. They felt that the approaches needed in the tests were much more difficult than those used while completing the chapter. Toward the middle of the year they found that thinking, concentration, and study were just as important in programmed materials as in textbooks.

After teaching for many years, this was a very frustrating experience and indeed a lot of work to have eighteen students demanding my attention for seventy minutes. Classroom management problems were somewhat magnified. It was more difficult to discipline a class with eighteen groups. Perhaps the only thing involved was my own security which was offset by the purposeful activity of the students.

This has certainly been a real learning experience for me. It has made me question my personal philosophy of teaching and revise it to a certain extent, especially with regards to individual differences.

There is a great deal more work in evaluation of students, individual help, and planning. However, personal satisfaction and improved student achievement all compensate for the above.

Although I was pleased with the results of my project, I can see where it can be improved in several ways. First, I intend to do more testing, as this data will be helpful in determining growth of the student. These tests will be given at the beginning of the year, at the end of the first semester, and again at the end of the year. Second, I plan to counsel individually with each student, helping him set up goals by actually showing him what degree of success he can attain. If I had done this last year, I feel that several students would have progressed further than they did. Finally, I will use filmstrips and films to aid the student in better understanding of certain mathematical principles.

The modern trend of reorganizing seems to indicate there is no longer a need for the existence of small high schools, but they cannot be eliminated entirely. If we are to fulfill our obligation as teachers, we must instruct these students as well as, if not better than, students are instructed in the larger schools.